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## Academic examinations and immunity: academic stress or examination stress?

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## ACADEMIC EXAMINATIONS AND IMMUNITY: ACADEMIC STRESS OR EXAMINATION STRESS?

Academic examinations are one of the most frequently used manipulations in stress research. In a recent paper, Stowell (1) discusses the uses and abuses of academic examinations in stress research, with a focus on psychoneuroimmunology. He emphasizes that the label "academic examination stress" covers a wide range of situations that may have very different psychological and immunological consequences. Hence, the results of academic examination studies are often difficult to compare, and conflicting findings are frequent. A clear example is the research literature on academic examinations and secretory immunoglobulin A (S-IgA). S-IgA is an immunological protein that is present in the secretions covering the mucosa, and it forms a first line of immunological defense against invading pathogens (2). To date, 13 studies on the effects of academic exams on salivary S-IgA have been published. Approximately half of these studies report a decrease in S-IgA, whereas the other half report an increase in S-IgA (2).

Stowell makes several reasonable recommendations that might help to clear up some of the noise in this literature. Although we generally concur with the author, we note that he fails to recognize that the stress of academic examinations has both acute (eg, immediately before an examination) and protracted (eg, during the preparation or review period) characteristics. This distinction is crucial because it explains most, if not all, variability between studies on S-IgA and academic examination stress.

In a systematic review of the literature, we categorized academic examination studies on the basis of whether saliva samples were collected close to (ie, during, or minutes before or after) a single examination, or sometime during the extended examination period (2). As

shown in Table 1, sorting studies according to this single criterion reveals a remarkably consistent picture, ie, *all* studies in which the samples were collected close to an actual examination were associated with increases in S-IgA, whereas the other studies were associated with decreases (one study in this category reported a null finding) (3–16).

Research within psychoneuroimmunology has repeatedly demonstrated that acute and protracted stressors can generate opposing results on the same parameters. This clearly also applies to the research on immunity and academic examination stress, which shows that the acute stress of an imminent exam is associated with enhanced S-IgA levels, whereas the protracted stress of an extended exam period is associated with lowered S-IgA levels. Based on these findings, we recommend that researchers carefully schedule the immune measurements in relation to the nearest exam. We further propose that the term "examination stress" should be reserved for situations in which a discrete exam is used as a stressor, whereas the term "academic stress" is more appropriate to denote prolonged academic pressures associated with exam periods.

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TABLE 1. Results of Academic Examination Studies That Measured S-IgA

	S-IgA concentration (ug/ml)	S-IgA secretion (ug/min)
	Samples taken during or close to a single exam	
McClelland et al., 1985 (3)	↑	
Evans et al., 1994 (4)		↑↑
Bosch et al., 1996, 1998 (5, 6)	↑↑	↑↑
Bristow et al., 1997 (7)	↑↑	↑↑
Spangler et al., 1997 (8)	↑↑	↑↑
Huwe et al., 1998 (9)	↑↑	↑↑
	Samples taken during the extended exam period	
Jemmott et al., 1983 (10)	↓	↓
Kiecolt-Glaser et al., 1984 (11)	↔	
Jemmott et al., 1988 (12)	↓	↓
Mouton et al., 1989 (13)	↓	↓
Li et al., 1997 (14)	↓	↓
Deinzer et al., 1998 (15)	↓	↓
Deinzer et al., 2000 (16)	↔*	↔

↑ increase; ↓ decrease; ↔ no change; empty cells indicate "not determined"

\* In this study a decrease was observed 1 and 2 weeks after the exam period

Studies are separated on basis of whether samples were taken close to (i.e., during, or minutes before or after) a single exam (upper panel), or were taken sometime during the extended exam period (lower panel).

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## RESPONSE

This letter is in response to considerations proposed by Bosch, Ring, de Geus, and Amerongen (1) that dealt with my previous paper on the use and abuse of academic examinations in stress research (2). To paraphrase, they felt I failed to adequately address the difference between acute and protracted characteristics of academic examination stress, which would otherwise provide a clear explanation for apparently contradictory findings in the literature on secretory immunoglobulin A. Second, they recommend: "the term 'examination stress' should be reserved for situations in which a discrete exam is used as a stressor, whereas the term 'academic stress' is more appropriate to denote the prolonged academic pressures associated with exam periods." I will briefly address these points in turn.

My review of the studies cited by Bosch et al. (1) supports their view that secretory immunoglobulin A may be increased or decreased depending on whether the examination saliva sample is collected within minutes of the exam-

ination or at some other time of the day. Most of these studies also differ on whether the baseline measurement was taken days or weeks vs. minutes before the examination. Thus, it is unclear if the transient increase in secretory immunoglobulin A is a true increase, or simply a return to normal from a chronically lowered state.

The distinction between acute (eg, laboratory stressors) and chronic stress (eg, care giving) is an important one, and we have addressed this elsewhere (3). Briefly, we too have noticed opposing results for acute and chronic stress on measures of the immune system, including delayed type hypersensitivity (4) and natural killer cell activity (5,6). Although some stressors are easily categorized as acute or chronic, we argued that academic examinations fall somewhere along this continuum, because they have variable periods of anxiety that precede the actual examination (7).

In conjunction with other studies, these data imply that a single measurement near the time of a stressful experience is not sufficient to capture transient changes that may be superimposed over longer-term changes. Thus, I reemphasize that researchers should collect repeated measures within the time immediately surrounding the exam and re-

member that the timing of physiological measurements is very important (2).

I propose that the term "academic examination stress," when accompanied by a description of what kind of examination was given, is sufficiently descriptive. Thus, one could distinguish academic examinations from other types of examinations such as dental, physical, or driving examinations. Second, "academic stress" should be considered a broad term that covers not only academic examinations but also other academically related stressors such as writing research papers, completing homework, working on group projects, and scheduling classes.

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